§21. Instability and Transport Driven by Electron Temperature Gradient Close to Critical

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The correlation of the electron temperature gradient (ETG) turbulence and the electron thermal transport was studied by Lee et al., Guzdar et al. and Horton et al. with quasilinear theory in the 1980s of the previous century. The so-called electron temperature profile consistency (" stiffness" as termed in recent literatures) observed in experiments was successfully explained with the formula for electron conductivity introduced in these works. Recently, Dorland et al. and Jenko et al. with gurokinetic nonlinear simulation also discussed the correlation of the ETG turbulence and the electron thermal transport. Electron thermal transport was studied in detail in recent experiments, showing that the thermal fluxes were offset linear functions of the TG parameter in region close to the critical. It is natural to argue that the critical gradients observed experimentally are the threshold for the ETG driven instabilities from the turbulent transport point of view.

In this study, the ETG driven instabilities and related turbulent transport in toroidal plasmas are studied with gyrokinetc theory. The maximum growth rate of the modes, which is often highlighted in studies of sheared flow suppression effects on the modes, is presented. The critical gradients, which may be compared with experimental observations, are accurately calculated without extrapolation. Estimations for the transport induced by the turbulence are formulated with quasilinear theory.

The obtained critical gradient parameters, $(R/L_{Te})^{ce}$ versus ε_n are showed in Fig.1 for several values of $\tau_i(=T_e/T_i)$.

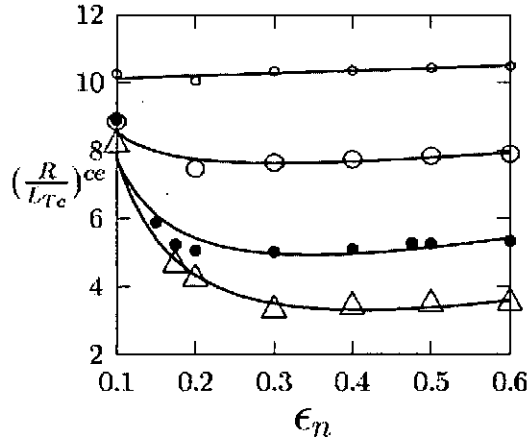

Fig.1 Critical gradient parameters $(R/L_{Te})^{ce}$ versus ε_n for τ_i = 3, 2, 1, and 0.33.

Electron transport induced by ETG turbulence is formulated using the databases of the calculations of parameter survey. Then , the scaling for transport was obtained and is shown to be in line with experimental observations.

Reference:

J. Q. Dong, Guangde Jian, A. K. Wang, H. Sanuki and K. Itoh, Nuclear Fusion 43(2003) 1183-1190.